Introduction

UV radiation is divided into three bands: UVA (315-400 nm), UVB (280-315 nm), and UVC (100-280 nm). Ozone absorbs very little UVA radiation. UVA is associated with aging and reddening of the skin, as well as cataract formation. Ozone strongly absorbs UVB, and UVB increased significantly at the surface in the early 1990s because of stratospheric ozone depletion (*Kerr and McElroy*, 1993; *Herman et al.*, 1996). UVB is associated with squamous cell carcinoma, but not necessarily with basal cell carcinoma or melanoma. UVB is also associated with the beneficial production of vitamin D. Stratospheric ozone absorbs all UVC, so no UVC is observed on the ground. Slight exposure to the potent UVC can cause mutations and even death.

An erythemal (or sunburn) action spectrum has been introduced to represent the average skin response over the UVB and UVA spectral regions (*McKinlay and Diffey*, 1987). This action spectrum is a composite of several investigators' measurements of the response of many different human skin types to UV radiation. Weighting the UVB and UVA irradiances by the action spectrum yields the erythemal effective irradiance or "dose rate". This dose rate represents the instantaneous amount of skin damaging UV radiation. Another term commonly used to indicate the UV intensity is UV index, which is expressed by multiplying the erythemal effective irradiance by 40. The U. S. Environmental Protection Agency (EPA) has devised guidelines for use of the UV index.

In the photosynthesis process, radiative energy from sunlight is converted to chemical energy by using CO_2 from the atmosphere. Solar energy in the spectrum of 400-700 nm, the so-called photosynthetically active radiation (PAR), plays a very important role in photosynthesis. The intensity of PAR affects the rate of photosynthesis, and hence also the carbon sequestration by ecosystems. Therefore, PAR is a key variable for modeling global gross and net primary production. This study defines PAR as the downwelling solar irradiance from 400-700 nm at the surface.

Surface UVB, UVA, UV index, and PAR are derived from Surface and Atmospheric Radiation Budget (SARB) product. Su et al. (2005, 2007) described the algorithms to derive the surface UV and PAR product.

Validation of PAR

PAR fluxes are routinely measured at the SURFRAD sites (Augustine et al. 2000) using quantum LI-COR sensor and its uncertainty is estimated to be ±10%. Figure 1 compares the PAR fluxes from SYN with SURFRAD measurements at Desert Rock, NV using data of 2002. Table 1 compares the PAR fluxes from SYN with those measured at the six SURFRAD sites using data of 2002. Bias is defined as SYN minus SURFRAD. Though PAR fluxes from SYN are higher than the SURFRAD measurements, the biases are all within the uncertainty of the PAR measurements.
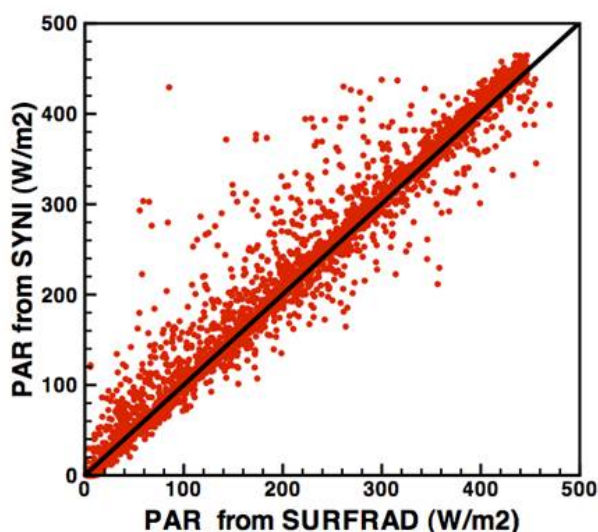

Figure 1. Comparison of PAR fluxes from SYN to those measured
at the Desert Rock, NV, using data of 2002.

Table 1: Total sample number, mean SYN PAR (Wm^{-2}), bias (SYN minus observed, Wm^{-2}), RMS error (Wm^{-2}), and percentage RMS error (RMS/observed*100%) for all data points, and for data points derived from CERES, from GEO, and from interpolations.

	Number	SYN	Bias	RMS (%)
All	23103	172.9	5.7	39.7 (24)
CERES	2296	260.0	9.1	48.8 (19)
GGEO	5893	176.4	6.1	39.3 (23)
Interp.	14914	158.0	5.0	38.2 (25)

Validation of UV product

Erythemal fluxes are also measured at the SURFRAD sites. Table 2 compares the erythemal UV fluxes from SYN with those measured at the six SURFRAD sites using data of 2002. Erythemal UV fluxes from SYN are smaller than those observed at the SURFRAD sites.

Table 2: Total sample number, mean SYN erythemal UV (mWm^{-2}), bias (SYN minus observed, mWm^{-2}), RMS error (mWm^{-2}), and percentage RMS error (RMS/observed*100%) for all data points, and for data points derived from CERES, from GEO, and from interpolations.

	Number	SYN	Bias	RMS (%)
All	24498	56.8	-2.4	18.1 (30)
CERES	2432	102.2	-3.0	25.3 (24)
GGEO	6279	57.8	-2.5	18.4 (30)
Interp.	15787	49.4	-2.3	16.6 (32)

UV dosage can be obtained by integrating the erythemal fluxes over the day. Figure 2 shows the comparison of the daily UV dosage derived from SYN and from SURFRAD measurements using data of 2002. The mean UV dosage from SURFRAD is 2450.2 J m^{-2} and the mean UV dosage from SYN is 2351.3 J m^{-2}. The SYN bias is about 4% of the SURFRAD observed value. Total Ozone Mapping Spectrometer (TOMS) also provides daily UV dosage data. Figure 3 shows the comparison of the UV dosage from TOMS and from SURFARD. The mean UV dosage from TOMS is 2891.2 J m^{-2}. The TOMS bias is about 18% of the SURFRAD observed value.

Conclusions

Initial validation shows that the surface PAR from SYN is higher than SURFRAD measurements by about 3% and the surface erythemal UV flux from SYN is about 4% smaller than the SURFRAD measurements. Also, daily UV dosage from SYN agrees with SURFRAD measurements much better than daily UV dosage from TOMS.
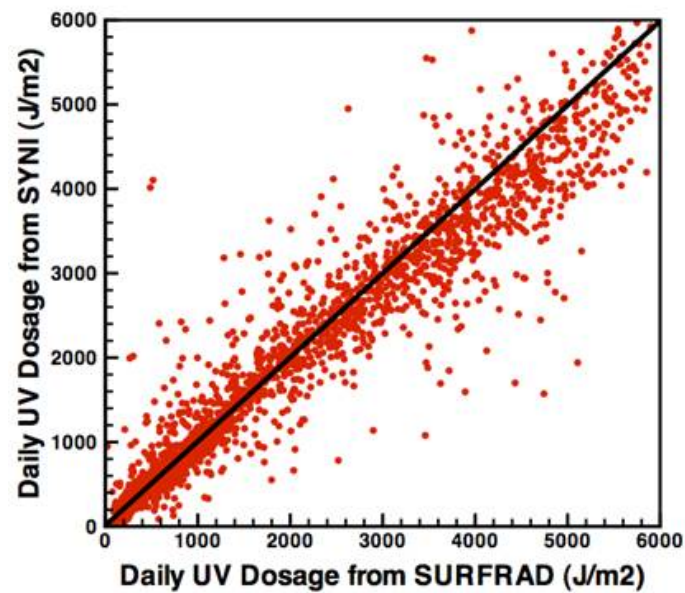

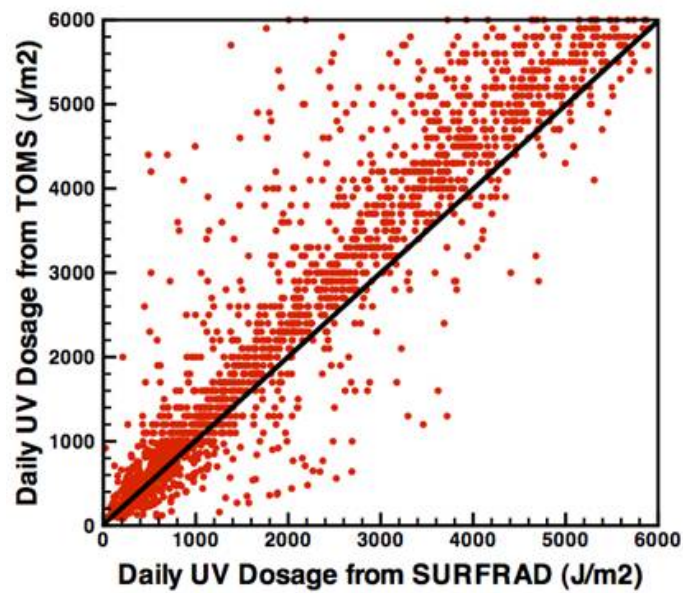Figure 2. Comparion of daily UV dosages observed at the SURFRAD sites with those derived from SYN.

Figure 3. Comparion of daily UV dosages observed at the SURFRAD sites with those derived from TOMS.

Reference:

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